ANNEX D PROBE CALIBRATION CERTIFICATE

Calibration Laboratory of
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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: SCS 0108

Client **CTTL (Auden)**

Certificate No: AM1DV2-1064_Jul19

CALIBRATION CERTIFICATE

Object	AM1DV2 - SN: 1064
Calibration procedure(s)	QA CAL-24.v4 Calibration procedure for AM1D magnetic field probes and TMFS in the audio range
Calibration date:	July 23, 2019

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	03-Sep-18 (No. 23488)	Sep-19
Reference Probe AM1DV2	SN: 1008	20-Dec-18 (No. AM1DV2-1008_Dec18)	Dec-19
DAE4	SN: 781	09-Jan-19 (No. DAE4-781_Jan19)	Jan-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	SN: 1050	01-Oct-13 (in house check Oct-17)	Oct-19
AMMI Audio Measuring Instrument	SN: 1062	26-Sep-12 (in house check Oct-17)	Oct-19

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 23, 2019

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[References

[1] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

[2] ANSI-C63.19-2011
American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

[3] DASY5 manual, Chapter: Hearing Aid Compatibility (HAC) T-Coil Extension

Description of the AM1D probe

The AM1D Audio Magnetic Field Probe is a fully shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The pickup coil is compliant with the dimensional requirements of [1+2]. The probe includes a symmetric low noise amplifier for the signal available at the shielded 3 pin connector at the side. Power is supplied via the same connector (phantom power supply) and monitored via the LED near the connector. The 7 pin connector at the end of the probe does not carry any signals, but determines the angle of the sensor when mounted on the DAE. The probe supports mechanical detection of the surface.
The single sensor in the probe is arranged in a tilt angle allowing measurement of 3 orthogonal field components when rotating the probe by 120° around its axis. It is aligned with the perpendicular component of the field, if the probe axis is tilted nominally 35.3° above the measurement plane, using the connector rotation and sensor angle stated below.
The probe is fully RF shielded when operated with the matching signal cable (shielded) and allows measurement of audio magnetic fields in the close vicinity of RF emitting wireless devices according to [1+2] without additional shielding.

Handling of the item

The probe is manufactured from stainless steel. In order to maintain the performance and calibration of the probe, it must not be opened. The probe is designed for operation in air and shall not be exposed to humidity or liquids. For proper operation of the surface detection and emergency stop functions in a DASY system, the probe must be operated with the special probe cup provided (larger diameter).

Methods Applied and Interpretation of Parameters

- *Coordinate System:* The AM1D probe is mounted in the DASY system for operation with a HAC Test Arch phantom with AMCC Helmholtz calibration coil according to [3], with the tip pointing to “southwest” orientation.
- *Functional Test:* The functional test preceding calibration includes test of
  Noise level
  RF immunity (1kHz AM modulated signal). The shield of the probe cable must be well connected.
  Frequency response verification from 100 Hz to 10 kHz.
- *Connector Rotation:* The connector at the end of the probe does not carry any signals and is used for fixation to the DAE only. The probe is operated in the center of the AMCC Helmholtz coil using a 1 kHz magnetic field signal. Its angle is determined from the two minima at nominally +120° and –120° rotation, so the sensor in the tip of the probe is aligned to the vertical plane in z-direction, corresponding to the field maximum in the AMCC Helmholtz calibration coil.
- *Sensor Angle:* The sensor tilting in the vertical plane from the ideal vertical direction is determined from the two minima at nominally +120° and –120°. DASY system uses this angle to align the sensor for radial measurements to the x and y axis in the horizontal plane.

Sensitivity: With the probe sensor aligned to the z-field in the AMCC, the output of the probe is compared to the magnetic field in the AMCC at 1 kHz. The field in the AMCC Helmholtz coil is given by the geometry and the current through the coil, which is monitored on the precision shunt resistor of the coil.

AM1D probe identification and configuration data

Item	**AM1DV2** Audio Magnetic 1D Field Probe
Type No	SP AM1 001 AF
Serial No	**1064**

Overall length	296 mm
Tip diameter	6.0 mm (at the tip)
Sensor offset	3.0 mm (centre of sensor from tip)
Internal Amplifier	40 dB

Manufacturer / Origin	Schmid & Partner Engineering AG, Zurich, Switzerland

Calibration data

Connector rotation angle	(in DASY system)	**103.0°**	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**0.63°**	+/- 0.5 ° (k=2)
Sensitivity at 1 kHz	(in DASY system)	**0.0657 V/(A/m)**	+/- 2.2 % (k=2)

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

ANNEX E DAE CALIBRATION CERTIFICATE

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Accreditation No.: SCS 0108

Client **CTTL - BJ (Auden)**

Certificate No: DAE4-1555_Aug18

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BN - SN: 1555

Calibration procedure(s): QA CAL-06.v29
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: August 20, 2018

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	31-Aug-17 (No:21092)	Aug-18
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	04-Jan-18 (in house check)	In house check: Jan-19
Calibrator Box V2.1	SE UMS 006 AA 1002	04-Jan-18 (in house check)	In house check: Jan-19

	Name	Function	Signature
Calibrated by:	Adrian Gehring	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	i.V.

Issued: August 20, 2018

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Accreditation No.: **SCS 0108**

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.540 ± 0.02% (k=2)	404.077 ± 0.02% (k=2)	405.023 ± 0.02% (k=2)
Low Range	3.92909 ± 1.50% (k=2)	3.94558 ± 1.50% (k=2)	3.97891 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	104.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199994.32	-1.11	-0.00
Channel X	+ Input	20004.21	2.27	0.01
Channel X	- Input	-19994.21	6.72	-0.03
Channel Y	+ Input	199991.01	-4.74	-0.00
Channel Y	+ Input	19999.15	-2.66	-0.01
Channel Y	- Input	-19999.37	1.70	-0.01
Channel Z	+ Input	199997.50	1.46	0.00
Channel Z	+ Input	19998.75	-3.06	-0.02
Channel Z	- Input	-20003.08	-1.96	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.23	-0.12	-0.01
Channel X	+ Input	201.73	0.03	0.02
Channel X	- Input	-197.79	0.32	-0.16
Channel Y	+ Input	2001.22	0.00	0.00
Channel Y	+ Input	201.15	-0.62	-0.31
Channel Y	- Input	-198.47	-0.28	0.14
Channel Z	+ Input	2001.41	0.23	0.01
Channel Z	+ Input	200.99	-0.67	-0.33
Channel Z	- Input	-199.42	-1.11	0.56

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-10.02	-11.33
	- 200	12.53	10.76
Channel Y	200	10.66	10.40
	- 200	-12.33	-12.29
Channel Z	200	-2.18	-2.52
	- 200	0.20	-0.09

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-0.85	-2.68
Channel Y	200	8.65	-	0.04
Channel Z	200	6.10	6.93	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15635	14959
Channel Y	15850	16040
Channel Z	16635	16604

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.40	-0.72	1.60	0.48
Channel Y	0.06	-0.99	1.84	0.46
Channel Z	-0.76	-2.17	0.18	0.48

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

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Accreditation No.: SCS 0108

Client **CTTL (Auden)**

Certificate No: DAE4-1331_Feb19

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 1331
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	February 06, 2019

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	03-Sep-18 (No:23488)	Sep-19
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-19 (in house check)	In house check: Jan-20
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-19 (in house check)	In house check: Jan-20

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	

Issued: February 6, 2019

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Accreditation No.: **SCS 0108**

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
    - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
    - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
    - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
    - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
    - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
    - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
    - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
    - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
    - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	405.242 ± 0.02% (k=2)	405.315 ± 0.02% (k=2)	405.081 ± 0.02% (k=2)
Low Range	3.95572 ± 1.50% (k=2)	3.99448 ± 1.50% (k=2)	4.01838 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	197.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199996.03	0.96	0.00
Channel X	+ Input	20003.08	1.84	0.01
Channel X	- Input	-19999.52	2.43	-0.01
Channel Y	+ Input	199998.14	2.99	0.00
Channel Y	+ Input	20001.08	-0.05	-0.00
Channel Y	- Input	-20002.02	-0.04	0.00
Channel Z	+ Input	199996.50	1.66	0.00
Channel Z	+ Input	19999.11	-2.09	-0.01
Channel Z	- Input	-20003.68	-1.62	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.08	0.43	0.02
Channel X	+ Input	200.82	-0.32	-0.16
Channel X	- Input	-198.42	0.17	-0.09
Channel Y	+ Input	2000.70	0.02	0.00
Channel Y	+ Input	200.61	-0.46	-0.23
Channel Y	- Input	-199.76	-1.08	0.54
Channel Z	+ Input	2000.97	0.31	0.02
Channel Z	+ Input	199.83	-1.19	-0.59
Channel Z	- Input	-200.44	-1.65	0.83

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	25.44	23.80
	- 200	-24.57	-26.00
Channel Y	200	4.40	4.15
	- 200	-5.34	-5.32
Channel Z	200	-0.55	-0.75
	- 200	-1.27	-1.71

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	6.56	-0.39
Channel Y	200	8.71	-	7.04
Channel Z	200	7.79	6.66	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15607	16065
Channel Y	15909	15986
Channel Z	16038	16066

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.45	-0.89	2.06	0.59
Channel Y	-0.92	-2.20	-0.12	0.36
Channel Z	0.53	-0.85	2.06	0.51

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	−0.01	-8	-9

ANNEX F THE EVALUATION OF SPOTCHECK AND GOOGLE DUO

F.1 The spot check results

Table F-1 Test results for 2/3G

Probe Position	Band	Ch.	Measurement Position (x mm, y mm)	ABM1 (dB A/m)	SNR (dB)	T category
transverse	**GSM 850**	190	-5.8,12.5	-4.19	42.16	**T4**
	WCDMA1900	9400	-2.9,-4.2	-5.41	49.97	**T4**
perpendicular	**GSM 850**	190	3.3,4.6	7.47	42.93	**T4**
	WCDMA1900	9400	-0.4,6.2	5.39	51.83	**T4**

Note:

1. Bluetooth and WiFi function is turn off and microphone is muted.
2. Signal strength measurement scan plots are presented in Annex B.
3. The volume is adjusted to maximum level during T-Coil testing.

Table F-2 Test results for LTE

Probe Position	Band	Ch.	Bandwidth	Measurement Position (x mm, y mm)	ABM1 (dB A/m)	SNR (dB)	T category
Transverse	**LTE B4**	20175	20M	2.5,12.5	-0.44	59.06	**T4**
Perpendicular	**LTE B2**	18900	20M	-0.4,6.2	5.47	46.48	**T4**

Note:

1. Bluetooth and WiFi function is turn off and microphone is muted.
2. The worse case of each band for signal strength measurement scan plots are presented in Annex B.
3. The volume is adjusted to maximum level during T-Coil testing.

Table F-3 Test results for WiFi

Probe Position	Mode	Ch.	Bandwidth	Measurement Position (x mm, y mm)	ABM1 (dB A/m)	SNR (dB)	Category T ?
Transverse	**802.11n**	6	20M	-5.5, 9.7	-2.01	42.76	**T4**
Perpendicular	**802.11n**	6	20M	-0.9, 6.6	5.65	46.57	**T4**

Note:

1. Bluetooth and WiFi function is turn off and microphone is muted.
2. The worse case of each mode for signal strength measurement scan plots are presented in Annex B.
3. The volume is adjusted to maximum level during T-Coil testing.

F.2 OTT VoIP test system and DUT configuration

F.2.1 Test System Setup for OTT VoIP T-coil Testing

General Note:

Regards the protocols, Google Duo, the highlighting section of the test set up, reference levels used, codec(s) and the fact that an investigation was done to determine the worst-case codec/rate documented in the test results below.

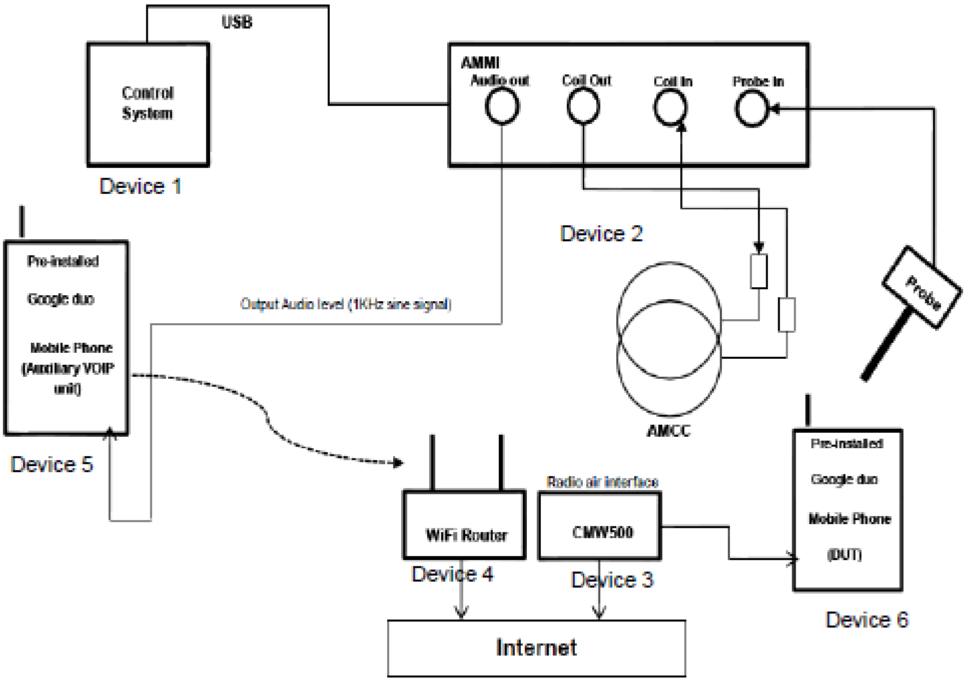
OTT VoIP Application

Google Duo is a pre-installed application on the DUT which allows for VoIP calls in a head-to-ear scenario. Duo uses the OPUS audio codec and supports a bitrate range of 6kbps to 75kbps. All air interfaces capable of a data connection were evaluated with Google Duo. When HAC testing we are using the Google Duo version is 26.0.179825522.alpha.DEV and the bitrate configuration can find at settings → Voice call parameters settings → Audio codec bitrate(6-75kbps).

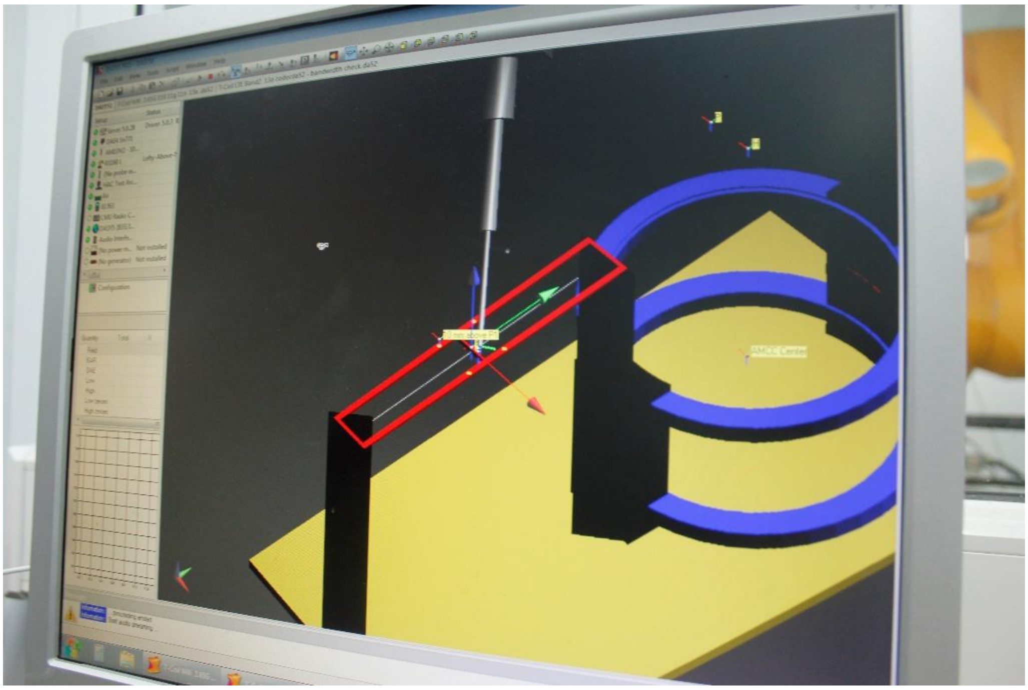
Test Procedure and Equipment Setup

The test procedure for OTT testing is identical to the section above, except for how the signal is sent to the DUT, as outlined in the diagram below.

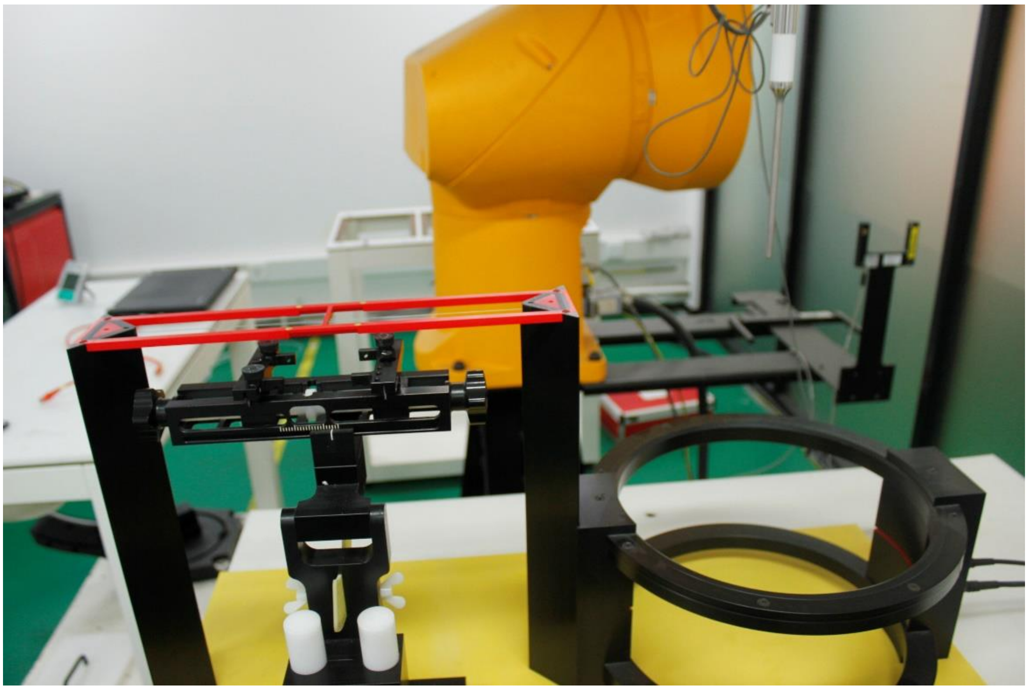
The AMMI is connected to the support device's Mic via Audio Data Line. The support device is connected to the Internet via Wi-Fi and the DUT is connected to the mobile base station via the technology under test. Using the DUT's OTT application, a VoIP call is established with the support device. The test signal is sent from the DASY PC to the AMMI, from the AMMI to the support device, and finally to the DUT. To exercise the license antenna, the DUT was simultaneously connected to an external AP and to a mobile base station.


USB
Control System
Device 1
AMMI
Audio out
Coil Out
Coil In
Probe In
Device 2
Pre-installed
Google duo
Mobile Phone
(Auxiliary VOIP unit)
Device 5
Output Audio level (1KHz sine signal)
AMCC
Probe
Pre-installed
Google duo
Mobile Phone
(DUT)
Radio air interface
WiFi Router
CMW500
Device 4
Device 3
Device 6
Internet

Device1：



Device2：



Device3：

Device4：

Device5：The auxiliary device is pre-installed with a test version of Google duo app, The test version app can control the configurations of audio codec bitrate

Device6：The photo of DUT are presented in the additional document: Appendix to test report No.I19Z62348-SEM01/02 The photos of HAC test

Audio Level Settings

According to KDB 285076 D02, the average speech level of -20dBm0 shall be used for protocols not specifically listed in Table 7.1 of ANSI C63.19-2001.

Determine Input Audio level is based on the Added additional dBFS level readout by Google Duo customize application and three steps need to do.

1. Input a gain value to readout the -23dBFS level as reference. (0dBFS = 3.14 dBm0)
2. Adjust gain level to readout the dBFS level until it changes to -24dBFS.
3. Based on the step 1 and 2, and then calculate the gain value(dB) by interpolation to get the -20dBm0 corresponding gain value.

Codec Bit-rate Investigation

An investigation between the various bit-rate configurations (Low/Mid/High bit rates for Narrowband, Wideband, and EVS) are documented (ABM, SNNR, frequency response) to determine the worst case bit-rate for each voice service type. The tables below compare the varying bit-rate configurations

Air Interface Investigation

Using the worst-case bit-rate and Radio Configuration found in §11.2/11.3/11.4, a limited set of bands/channel/ bandwidths were then tested to confirm that there is no effect to the T-rating when changing the band/channel/bandwidth, it is necessary to report only a set band/channel/bandwidth for each orientation for a voice service/air interface.

F.2.2 Codec Configuration

An investigation was performed for each applicable data mode to determine the audio codec configuration to be used for testing. The 6kbps codec setting was used for the audio codec on the auxiliary VoIP unit for OTT VoIP T-coil testing. See below tables for comparisons between codec data rates on all applicable data modes:

Table F.2-1 Codec Investigation – OTT over EDGE

Codec Setting	64kbps	6kbps	Orientation	Channel
ABM1 (dBA/m)	6.75	5.15	Z(axial)	661
Frequency Response	Pass	Pass		
SNR (dB)	55.31	54.53		

Table F.2-2 Codec Investigation – OTT over HSPA

Codec Setting	64kbps	6kbps	Orientation	Channel
ABM1 (dBA/m)	7.31	6.45	Z(axial)	9400
Frequency Response	Pass	Pass		
SNR (dB)	50.19	49.81		

Table F.2-3 Codec Investigation – OTT over LTE

Codec Setting	64kbps	6kbps	Orientation	Band/BW	Channel
ABM1 (dBA/m)	7.83	8.12	Z(axial)	B2/20M	18900
Frequency Response	Pass	Pass			
SNR (dB)	50.12	49.03			

Table F.2-4 Codec Investigation – OTT over WiFi

Codec Setting	64kbps	6kbps	Orientation	Band/BW	Channel
ABM1 (dBA/m)	5.29	7.31	Z(axial)	2.4GHz 802.11b	6
Frequency Response	Pass	Pass			
SNR (dB)	46.54	46.13			

F.2.3 Radio Configuration for OTT VoIP (LTE)

An investigation was performed to determine the modulation and RB configuration to be used for testing. 20MHz BW，QPSK, 1RB, 50RB offset was used for the testing as the worst-case configuration for the handset. See below table for comparisons between different radio configurations:

Table F.2-5 OTT VoIP (LTE) SNR by Radio Configuration

Band	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	SNR [dB]
LTE B2	18900	20	QPSK	1	0	8.90	50.44
LTE B2	18900	20	QPSK	1	50	8.12	49.03
LTE B2	18900	20	QPSK	1	99	7.78	50.74
LTE B2	18900	20	QPSK	50	0	8.55	50.11
LTE B2	18900	20	QPSK	50	25	7.63	49.71
LTE B2	18900	20	QPSK	50	50	8.51	49.57
LTE B2	18900	20	QPSK	100	0	8.39	50.26
LTE B2	18900	20	16QAM	1	50	9.27	50.05
LTE B2	18900	20	64QAM	1	50	9.02	49.49
LTE B2	18900	15	QPSK	1	50	8.13	50.51
LTE B2	18900	10	QPSK	1	50	7.28	49.42
LTE B2	18900	5	QPSK	1	50	9.04	49.86
LTE B2	18900	3	QPSK	1	50	8.82	50.28
LTE B2	18900	1.4	QPSK	1	50	8.91	50.72

An investigation was performed to determine the worst-case LTE band to be used for OTT VoIP testing. LTE Band 2 of FDD were used for the testing as the worst-case configuration for the handset. See below table for comparisons between different LTE bands:

Table F.2-6 OTT VoIP (LTE) SNR by LTE bands

Band	Channel	Bandwidth [MHz]	Modulation	RB Size	RB Offset	ABM1 [dB(A/m)]	SNR [dB]
LTE B2	21100	20	QPSK	1	50	8.12	49.03
LTE B4	20175	20	QPSK	1	50	7.48	48.15
LTE B5	20525	10	QPSK	1	50	8,15	49.85
LTE B12	23095	10	QPSK	1	50	7.72	50.11
LTE B14	23330	10	QPSK	1	50	8.96	49.57
LTE B30	27710	10	QPSK	1	50	8.29	49.84

F.2.4 Radio Configuration for OTT VoIP (WiFi)

An investigation was performed on all applicable data rates and modulations to determine the radio configuration to be used for testing. See below tables for comparisons between different radio configurations in each 802.11 standard:

Table F.2-7 802.11b SNR by Radio Configuration

Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	SNR [dB]
802.11b	6	DSSS	1	7.31	46.13
802.11b	6	DSSS	2	6.05	45.91
802.11b	6	CCK	5.5	6.29	46.37
802.11b	6	CCK	11	7.17	46.48

Table F.2-8 802.11g SNR by Radio Configuration

Mode	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	SNR [dB]
802.11g	6	BPSK	6	6.47	47.21
802.11g	6	BPSK	9	7.93	47.14
802.11g	6	QPSK	12	7.70	46.60
802.11g	6	QPSK	18	6.89	47.35
802.11g	6	16-QAM	24	7.88	47.46
802.11g	6	16-QAM	36	6.99	47.41
802.11g	6	64-QAM	48	6.76	47.86
802.11g	6	64-QAM	54	7.74	46.75

Table F.2-9 802.11n 20MHz BW SNR by Radio Configuration

Mode	Bandwidth [MHz]	Channel	Modulation	Data Rate [Mbps]	ABM1 [dB(A/m)]	SNR [dB]
802.11n	20	6	BPSK	6.5	7.67	47.88
802.11n	20	6	QPSK	13	7.71	47.13
802.11n	20	6	QPSK	19.5	7.15	47.16
802.11n	20	6	16-QAM	26	6.74	47.39
802.11n	20	6	16-QAM	39	7.62	47.64
802.11n	20	6	64-QAM	52	6.96	47.85
802.11n	20	6	64-QAM	58.5	6.46	47.17
802.11n	20	6	64-QAM	65	8.07	47.11

F.2.5 Test results for OTT VoIP

Table F.2-10 Test results for 2/3G

Probe Position	Band	Ch.	Measurement Position (x mm, y mm)	ABM1 (dB A/m)	SNR (dB)	Category T ?
Transverse	EDGE850(2TX)	190	1.2,8.4	-2.31	50.16	T4
	EDGE1900(2TX)	661	0.8,14.6	-1.11	49.98	T4
	W850	4407	0.2,-3.9	-0.98	52.18	T4
	W1900	9800	0.8, -4.2	-1.45	53.27	T4
	W1700	1637	-4.2,-4.2	-1.08	49.21	T4
Perpendicular	EDGE850(2TX)	190	-0.9,7.1	5.34	52.31	T4
	EDGE1900(2TX)	661	-0.4,6.2	5.15	54.53	T4
	W850	4407	-1.1,5.6	4.31	50.26	T4
	W1900	9800	-0.4,7.1	6.45	49.81	T4
	W1700	1637	-1.2,4.6	6.74	49.10	T4

Note:

1. Bluetooth and WiFi function is turn off and microphone is muted.
2. Signal strength measurement scan plots are presented in Annex B.
3. The volume is adjusted to maximum level during T-Coil testing.

Table F.2-11 Test results for LTE

Probe Position	Band	Ch.	Band width	Measurement Position (x mm, y mm)	ABM1 (dB A/m)	SNR (dB)	Category T ?
Transverse	LTE B4	20175	20	-7.5,-4.2	-6.45	42.76	T4
Perpendicular	LTE B4	20175	20	0,8.3	7.48	48.15	T4

Note:

1. Bluetooth and WiFi function is turn off and microphone is muted.
2. The worse case of each band for signal strength measurement scan plots are presented in Annex B.
3. The volume is adjusted to maximum level during T-Coil testing.

Table F.2-12 Test results for WiFi

Probe Position	Mode	Ch.	Bandwidth	Measurement Position (x mm, y mm)	ABM1 (dB A/m)	SNR (dB)	Category T ?
Transverse	802.11b	6	20M	-5,9.2	-1.07	39.69	T4
	802.11g	6	20M	-4.2,8.7	-2.11	40.47	T4
	802.11n	6	20M	-3.6,9.1	-1.31	40.23	T4
Perpendicular	802.11b	6	20M	-4.2,5	6.05	45.91	T4
	802.11g	6	20M	0.4,4.6	7.70	46.60	T4
	802.11n	6	20M	-2.7,4.1	8.07	47.11	T4

Note:

1. Bluetooth and WiFi function is turn off and microphone is muted.
2. The worse case of each mode for signal strength measurement scan plots are presented in Annex B.
3. The volume is adjusted to maximum level during T-Coil testing.

F.3 Test plots of spot check

T-Coil GSM 850 Transverse
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5°C
Communication System: GSM 850; Frequency: 836.6 MHz; Duty Cycle: 1:8.3
Probe: AM1DV2 - 1064;

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated

Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

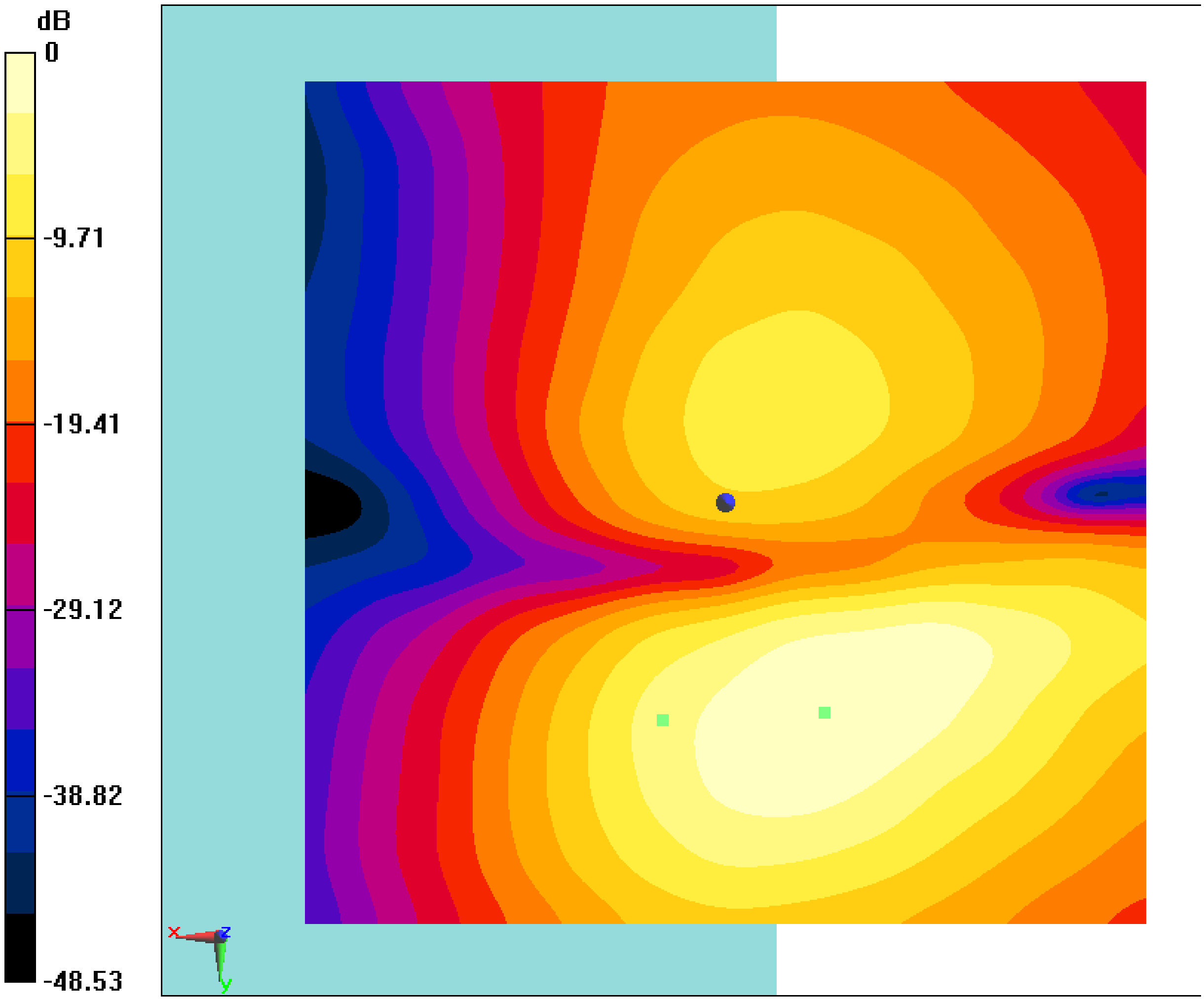
Cursor:
ABM1 = -0.06 dBA/m
BWC Factor = 0.16 dB
Location: 3.8, 12.9, 3.7 mm

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated

SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 42.16 dB
ABM1 comp = -4.19 dBA/m
BWC Factor = 0.16 dB
Location: -5.8, 12.5, 3.7 mm



0 dB = 0.9935 A/m = -0.06 dBA/m

Fig F.3.1 T-Coil GSM 850

T-Coil GSM 850 Perpendicular
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5°C
Communication System: GSM 850; Frequency: 836.6 MHz; Duty Cycle: 1:8.3
Probe: AM1DV2 - 1064;

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 12.2kbps/ABM Interpolated

Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

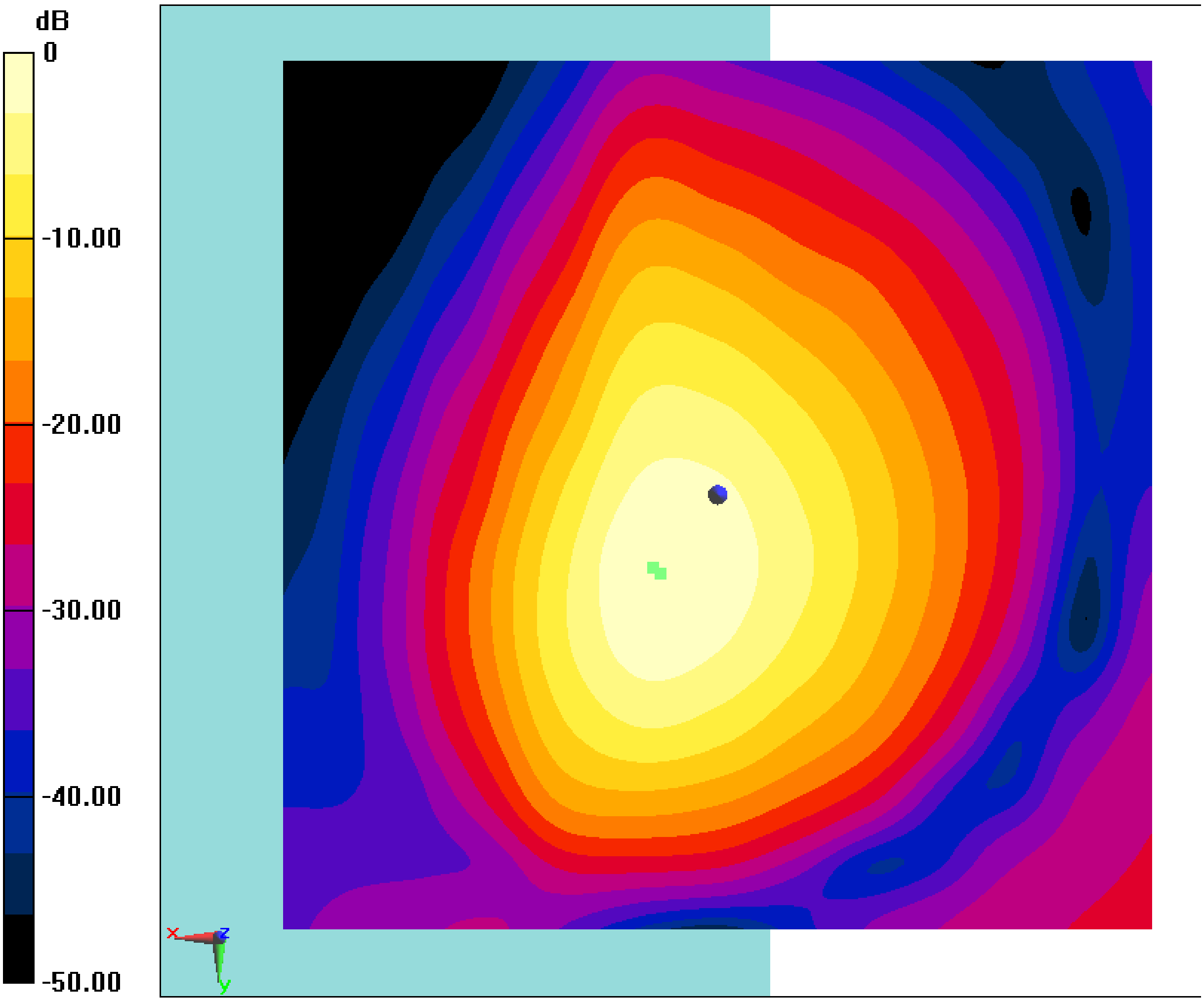
Cursor:
ABM1 = 7.55 dBA/m
BWC Factor = 0.16 dB
Location: 3.8, 4.2, 3.7 mm

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 12.2kbps/ABM Interpolated

SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 42.93 dB
ABM1 comp = 7.47 dBA/m
BWC Factor = 0.16 dB
Location: 3.3, 4.6, 3.7 mm



0 dB = 2.385 A/m = 7.55 dBA/m

Fig F.3.2 T-Coil GSM 850

T-Coil WCDMA 1900 Transverse
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5ºC
Communication System: WCDMA 1900; Frequency: 1880 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated

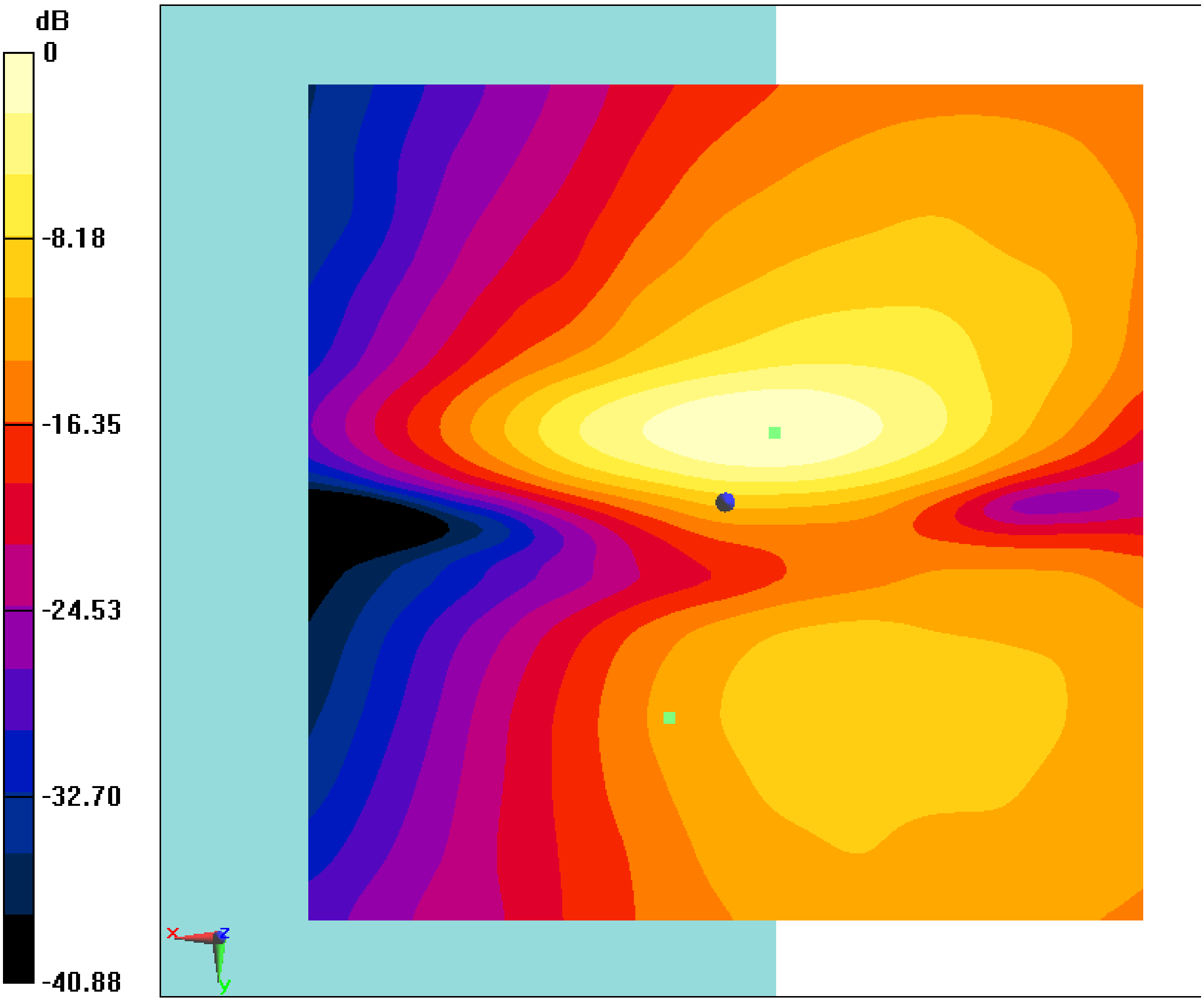
Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 = -0.29 dBA/m
BWC Factor = 0.16 dB
Location: 3.3, 12.9, 3.7 mm

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated

SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 49.97 dB
ABM1 comp = -5.41 dBA/m
BWC Factor = 0.16 dB
Location: -2.9, -4.2, 3.7 mm



0 dB = 0.9673 A/m = -0.29 dBA/m

Fig F.3.3 T-Coil WCDMA 1900

T-Coil WCDMA 1900 Perpendicular
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5ºC
Communication System: WCDMA 1900; Frequency: 1880 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 12.2kbps/ABM Interpolated

Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

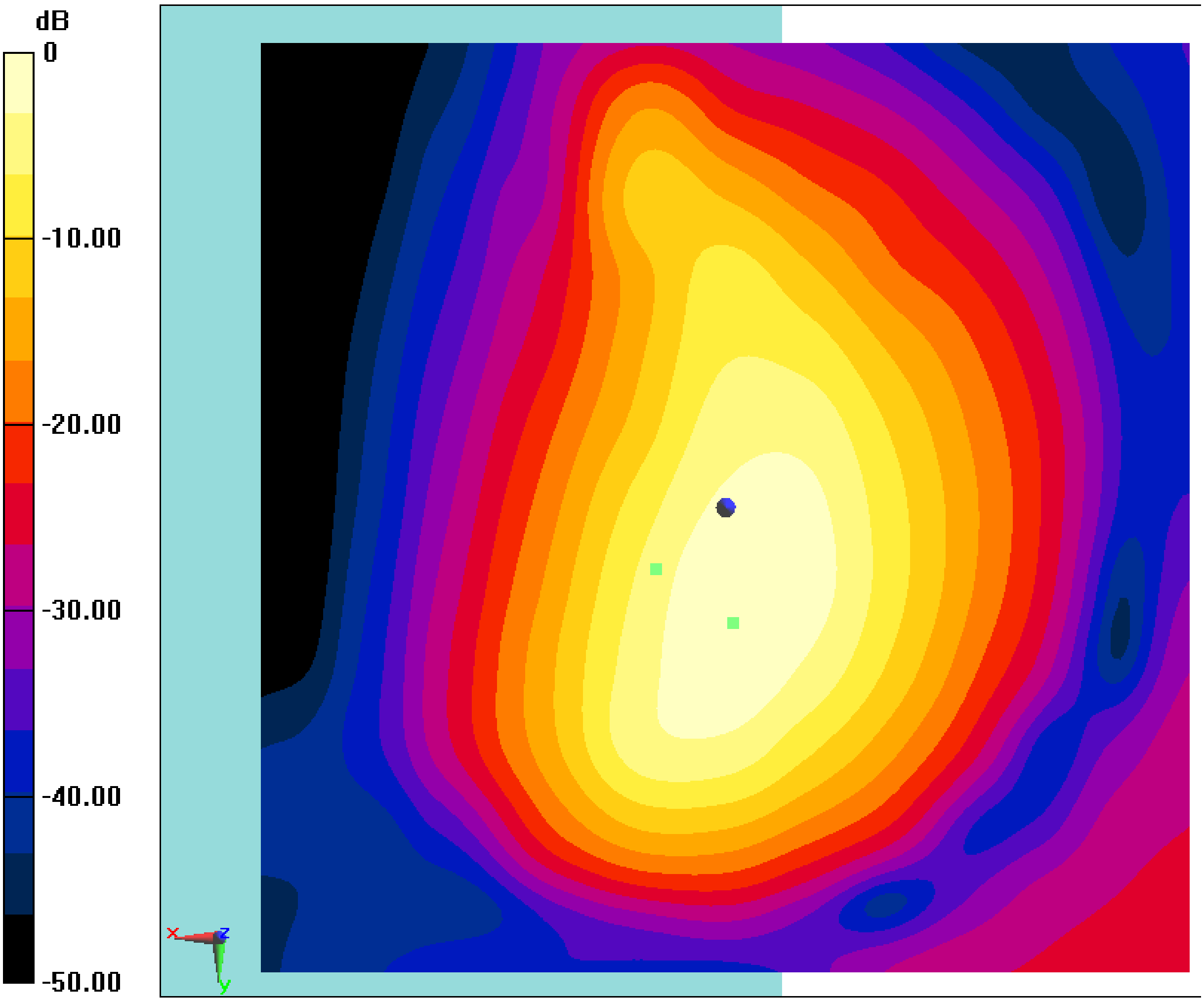
Cursor:
ABM1 = 7.30 dBA/m
BWC Factor = 0.16 dB
Location: 3.8, 3.3, 3.7 mm

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 12.2kbps/ABM Interpolated

SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 51.83 dB
ABM1 comp = 5.39 dBA/m
BWC Factor = 0.16 dB
Location: -0.4, 6.2, 3.7 mm



0 dB = 2.316 A/m = 7.30 dBA/m

Fig F.3.4 T-Coil WCDMA 1900

T-Coil LTE B4 20M Transverse
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1 kg/m^3
Ambient Temperature:22.5ºC
Communication System: LTE B4; Frequency: 1732.5 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 20M/ABM

Interpolated Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

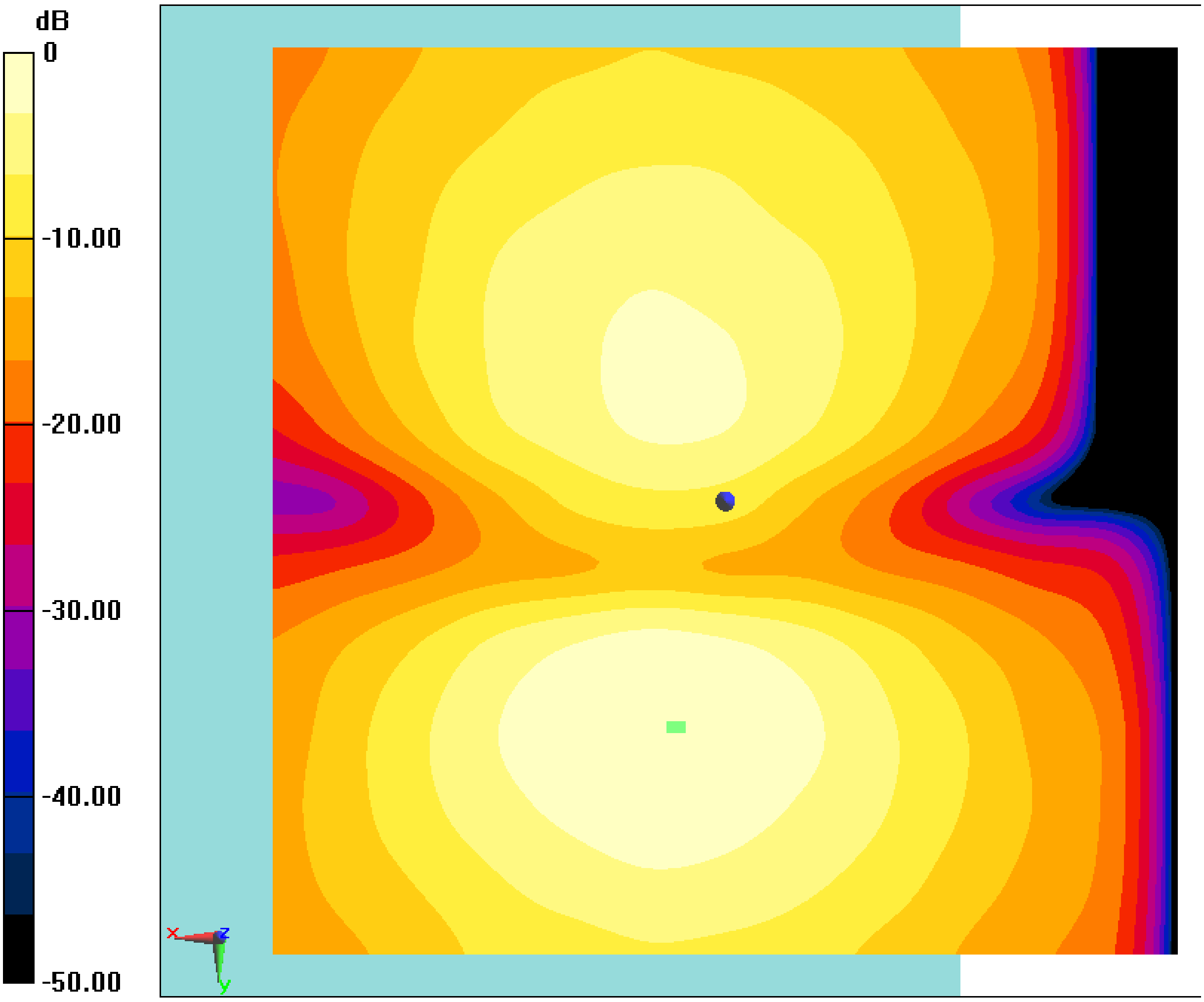
Cursor:
ABM1 = -0.43 dBA/m
BWC Factor = 0.16 dB
Location: 2.9, 12.5, 3.7 mm

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 20M/ABM

Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 59.06 dB
ABM1 comp = -0.44 dBA/m

BWC Factor = 0.16 dB
Location: 2.5, 12.5, 3.7 mm



0 dB = 0.9519 A/m = -0.43 dBA/m

Fig F.3.5 T-Coil LTE B4

T-Coil LTE B2 20M Perpendicular
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5ºC
Communication System: LTE B2; Frequency: 1880 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 20M/ABM Interpolated

Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 = 7.45 dBA/m
BWC Factor = 0.16 dB
Location: 3.3, 2.9, 3.7 mm

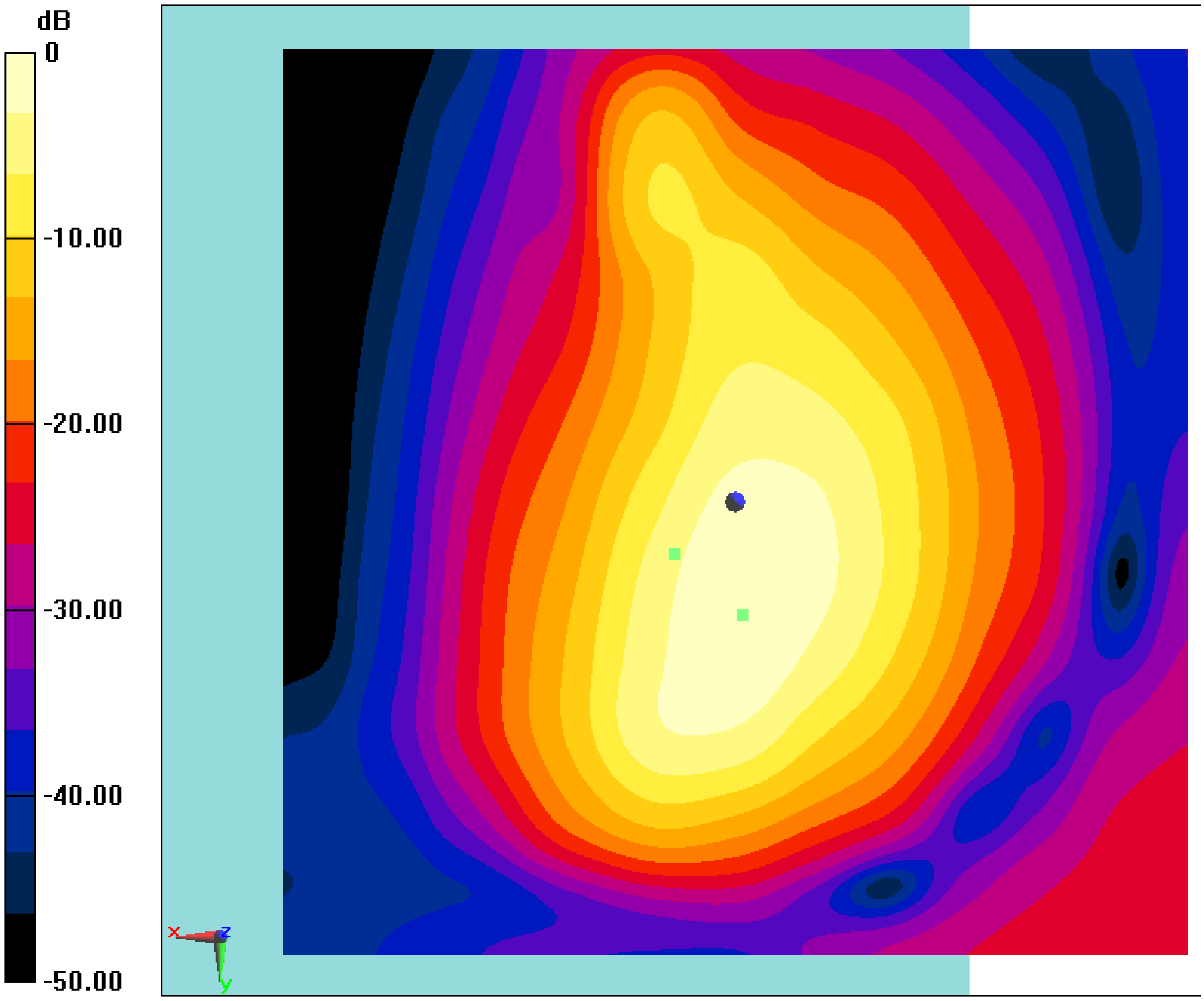
T-Coil/General Scans/z (axial) 4.2mm 50 x 50 20M/ABM Interpolated

SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 46.48 dB
ABM1 comp = 5.47 dBA/m

BWC Factor = 0.16 dB
Location: -0.4, 6.2, 3.7 mm



0 dB = 2.358 A/m = 7.45 dBA/m

Fig F.3.6 T-Coil LTE B2

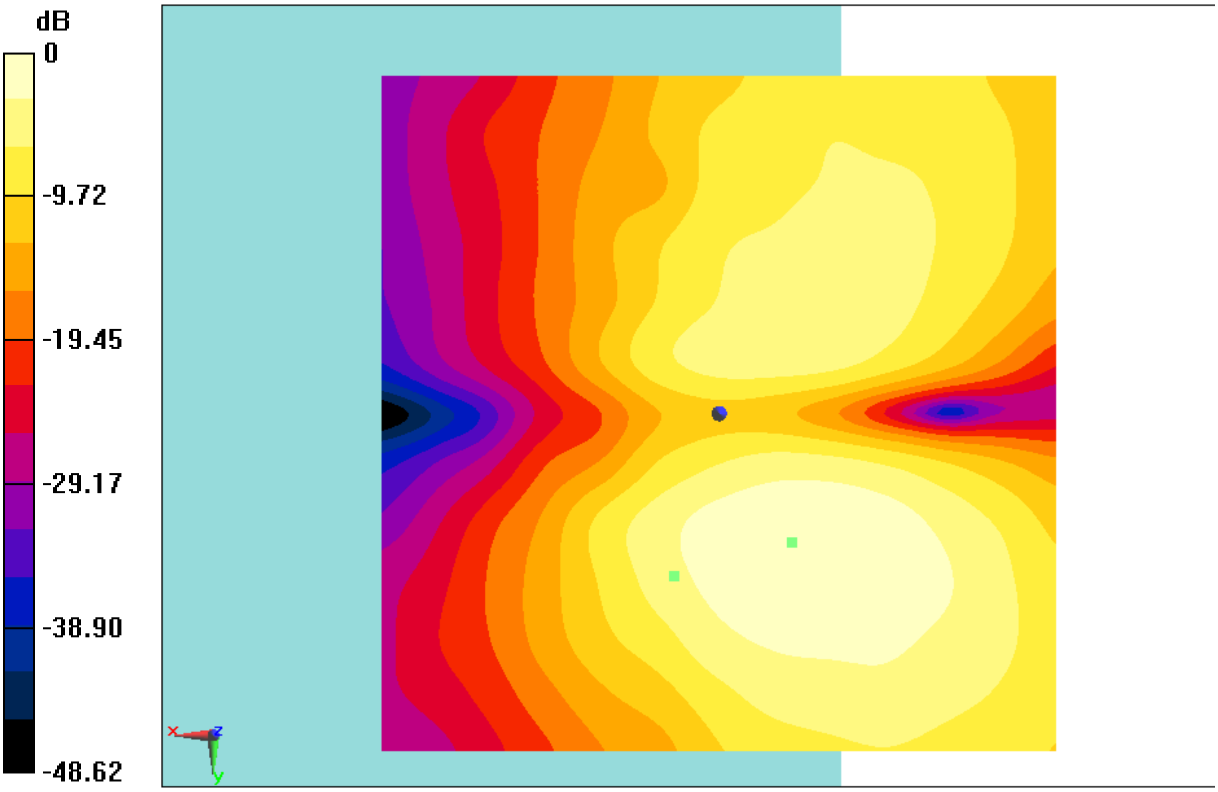
T-Coil WiFi-2.4G 11n Transverse
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5ºC
Communication System: WiFi-2.4G; Frequency: 2437 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

y (transversal) 4.2mm 50 x 50/ABM Interpolated Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 = 1.97 dBA/m
BWC Factor = 0.16 dB
Location: 3.3, 12.1, 3.7 mm

y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 42.76 dB
ABM1 comp = -2.01 dBA/m
BWC Factor = 0.16 dB
Location: -5.5, 9.7, 3.7 mm



0 dB = 1.255 A/m = 1.97 dBA/m

Fig F.3.7 T-Coil WiFi-2.4G

T-Coil WiFi-2.4G 11n Perpendicular
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5ºC
Communication System: WiFi-2.4G; Frequency: 2437 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

z (axial) 4.2mm 50 x 50/ABM Interpolated Signal(x,y,z) (121x121x1):

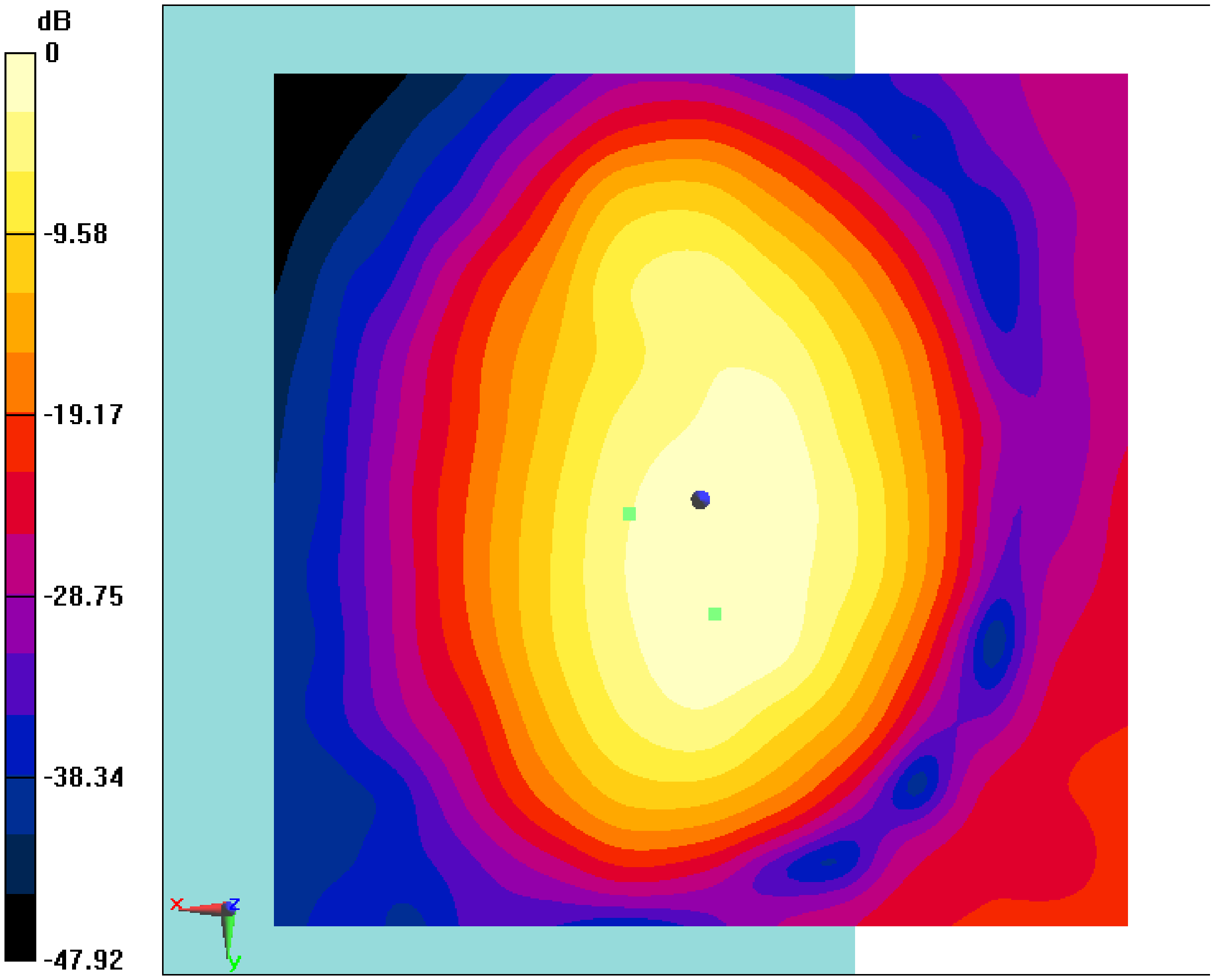
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 = 9.91 dBA/m
BWC Factor = 0.16 dB
Location: 4.2, 0.8, 3.7 mm

z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 46.57 dB
ABM1 comp = 5.65 dBA/m
BWC Factor = 0.16 dB
Location: -0.9, 6.6, 3.7 mm



0 dB = 3.130 A/m = 9.91 dBA/m

Fig F.3.8 T-Coil WiFi-2.4G

F.4 Test plots of Google duo

T-Coil WCDMA 1700 Transverse

Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5ºC
Communication System: WCDMA 1700; Frequency: 1732.4 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated

Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

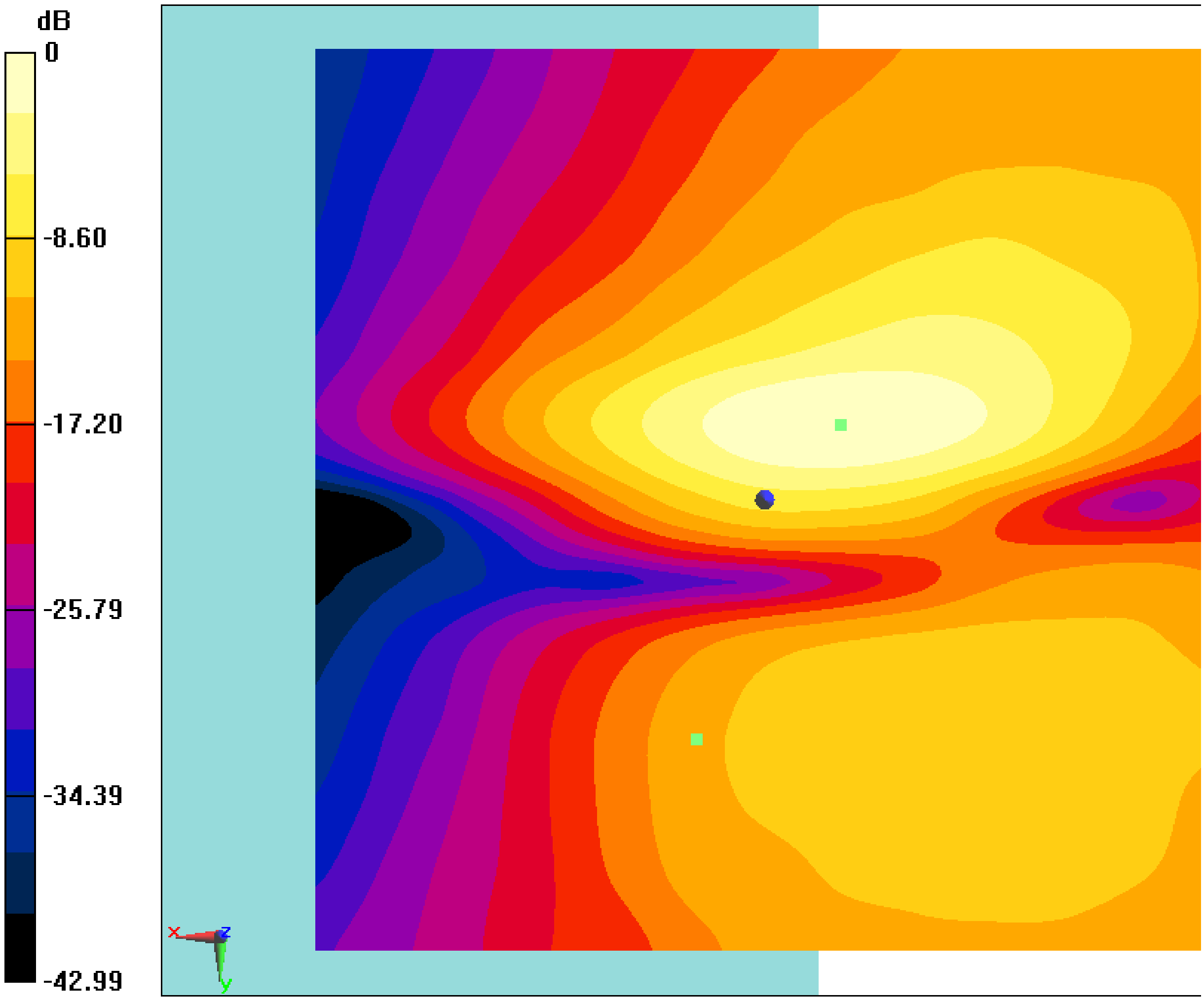
Cursor:
ABM1 = 4.19 dBA/m
BWC Factor = 0.16 dB
Location: 3.8, 13.3, 3.7 mm

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50/ABM Interpolated

SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 49.21 dB
ABM1 comp = -1.08 dBA/m
BWC Factor = 0.16 dB
Location: -4.2, -4.2, 3.7 mm



0 dB = 1.620 A/m = 4.19 dBA/m

Fig F.4.1 T-Coil WCDMA 1700

T-Coil WCDMA 1700 Perpendicular
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1 kg/m^3
Ambient Temperature:22.5ºC
Communication System: WCDMA 1700; Frequency: 1732.4 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 4.75kbps/ABM Interpolated

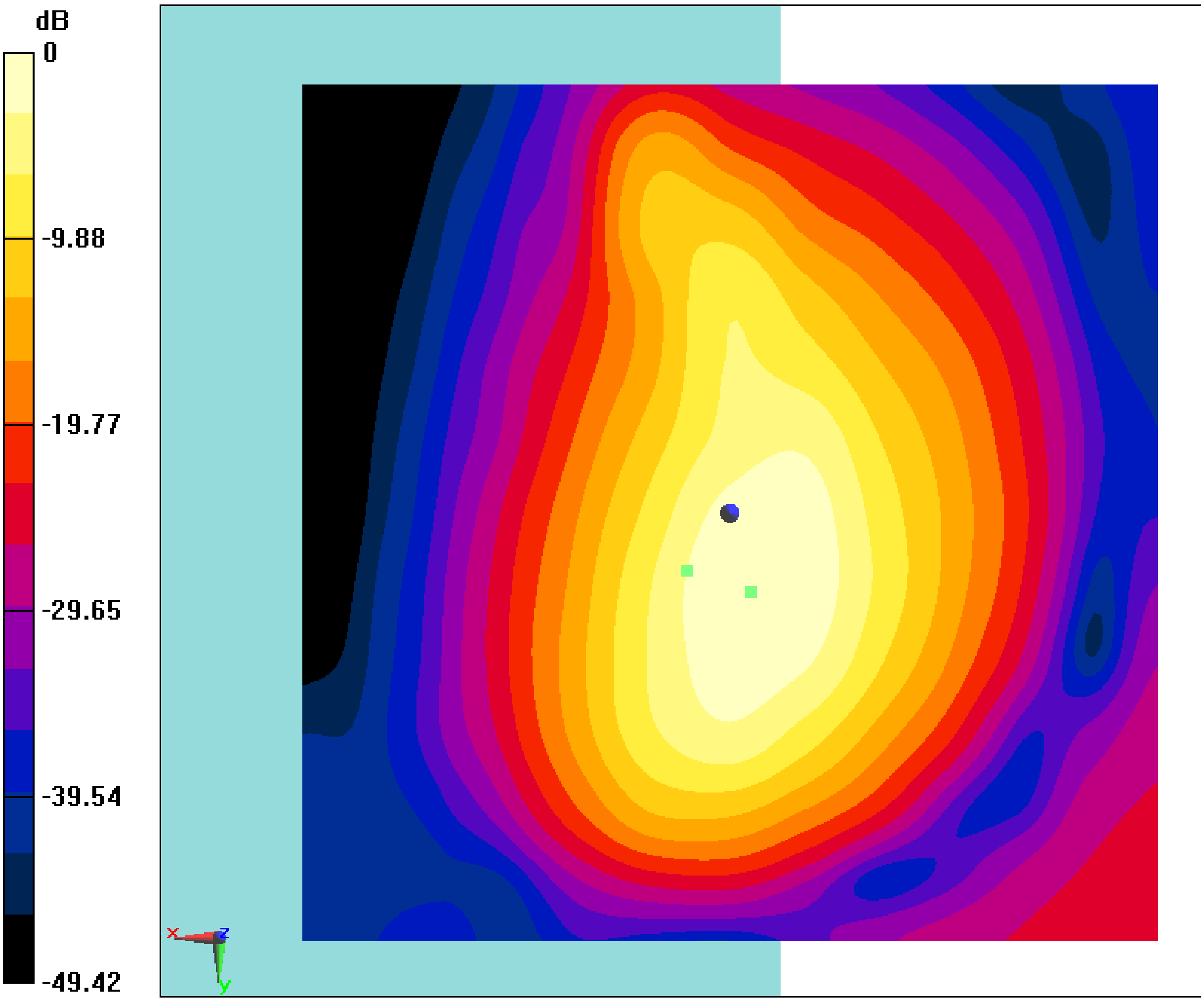
Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 = 8.13 dBA/m
BWC Factor = 0.16 dB
Location: 2.5, 3.3, 3.7 mm

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 4.75kbps/ABM Interpolated

SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 49.10 dB
ABM1 comp = 6.74 dBA/m
BWC Factor = 0.16 dB
Location: -1.2, 4.6, 3.7 mm



0 dB = 2.550 A/m = 8.13 dBA/m

Fig F.4.2 T-Coil WCDMA 1700

T-Coil LTE B4 20M Transverse
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5°C
Communication System: LTE B4; Frequency: 1732.5 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 20M/ABM

Interpolated Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

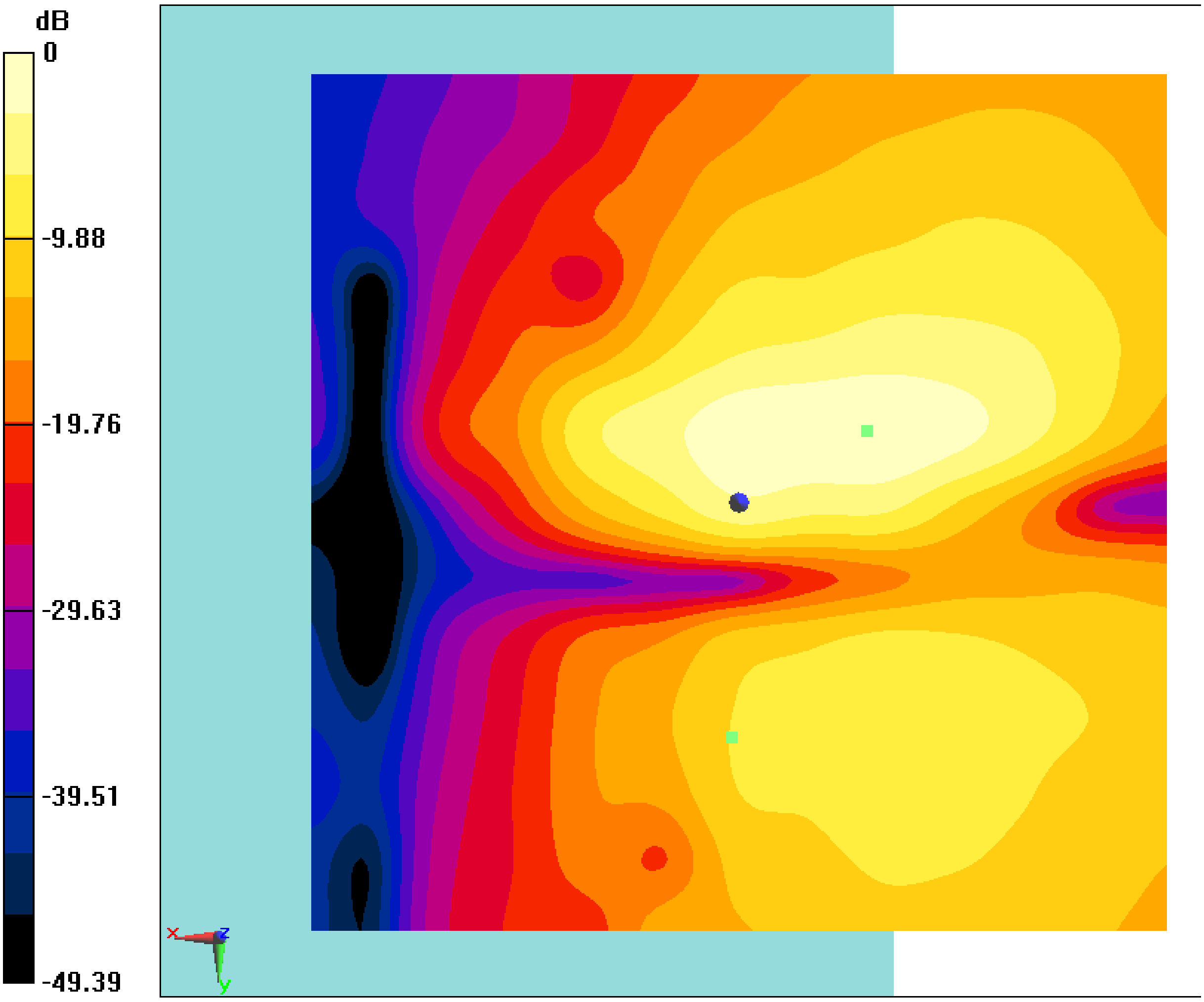
Cursor:
ABM1 = 1.69 dBA/m
BWC Factor = 0.16 dB
Location: 0.4, 13.7, 3.7 mm

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 20M/ABM

Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 42.76 dB
ABM1 comp = -6.45 dBA/m

BWC Factor = 0.16 dB
Location: -7.5, -4.2, 3.7 mm



0 dB = 1.215 A/m = 1.69 dBA/m

Fig F.4.3 T-Coil LTE B4

T-Coil LTE B4 10M Perpendicular
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5ºC
Communication System: LTE B4; Frequency: 1732.5 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 20M/ABM Interpolated

Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 = 10.36 dBA/m
BWC Factor = 0.16 dB
Location: 3.3, 4.2, 3.7 mm

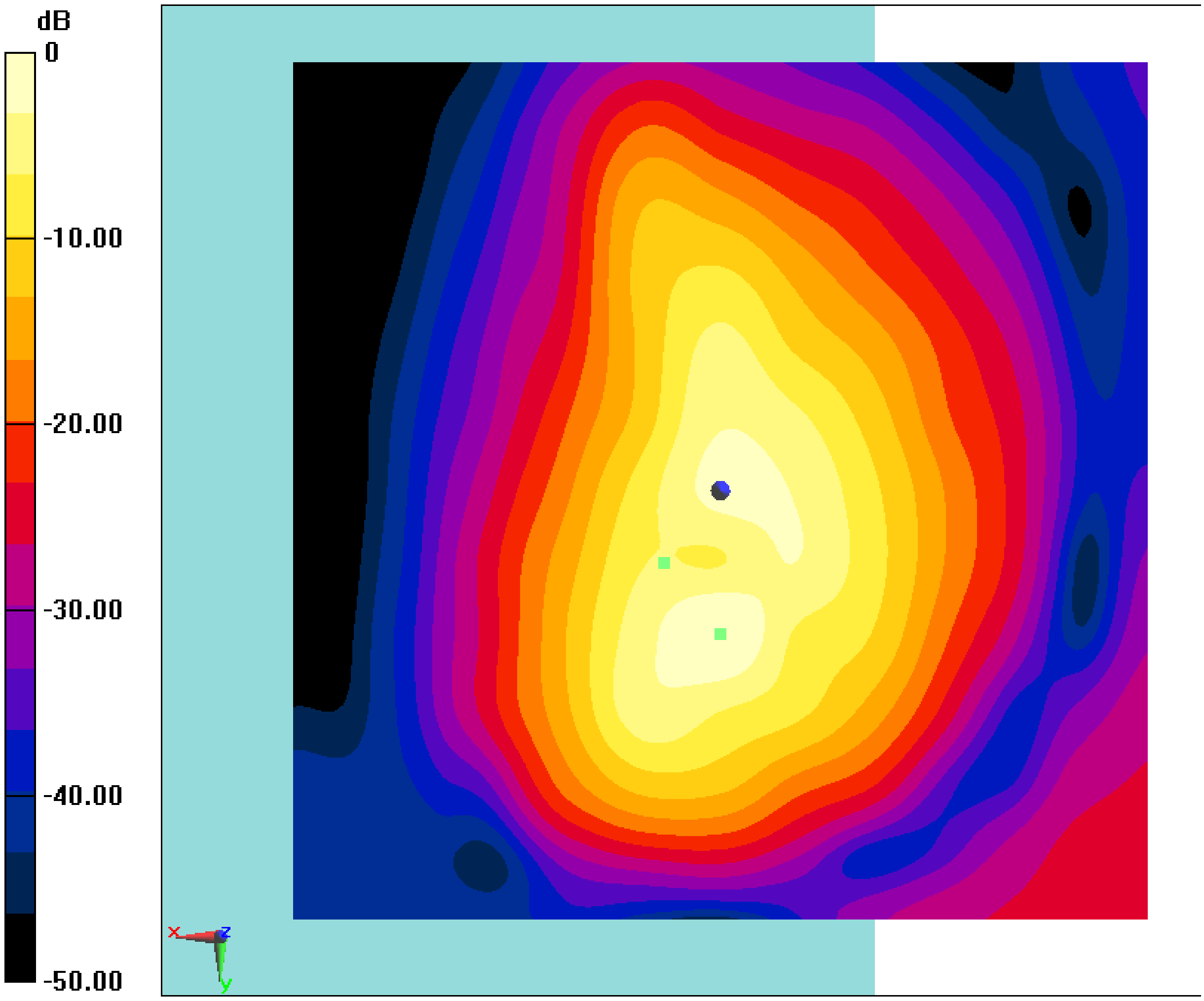
T-Coil/General Scans/z (axial) 4.2mm 50 x 50 20M/ABM Interpolated

SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 48.15 dB
ABM1 comp = 7.48 dBA/m

BWC Factor = 0.16 dB
Location: 0, 8.3, 3.7 mm



0 dB = 3.297 A/m = 10.36 dBA/m

Fig F.4.4 T-Coil LTE B4

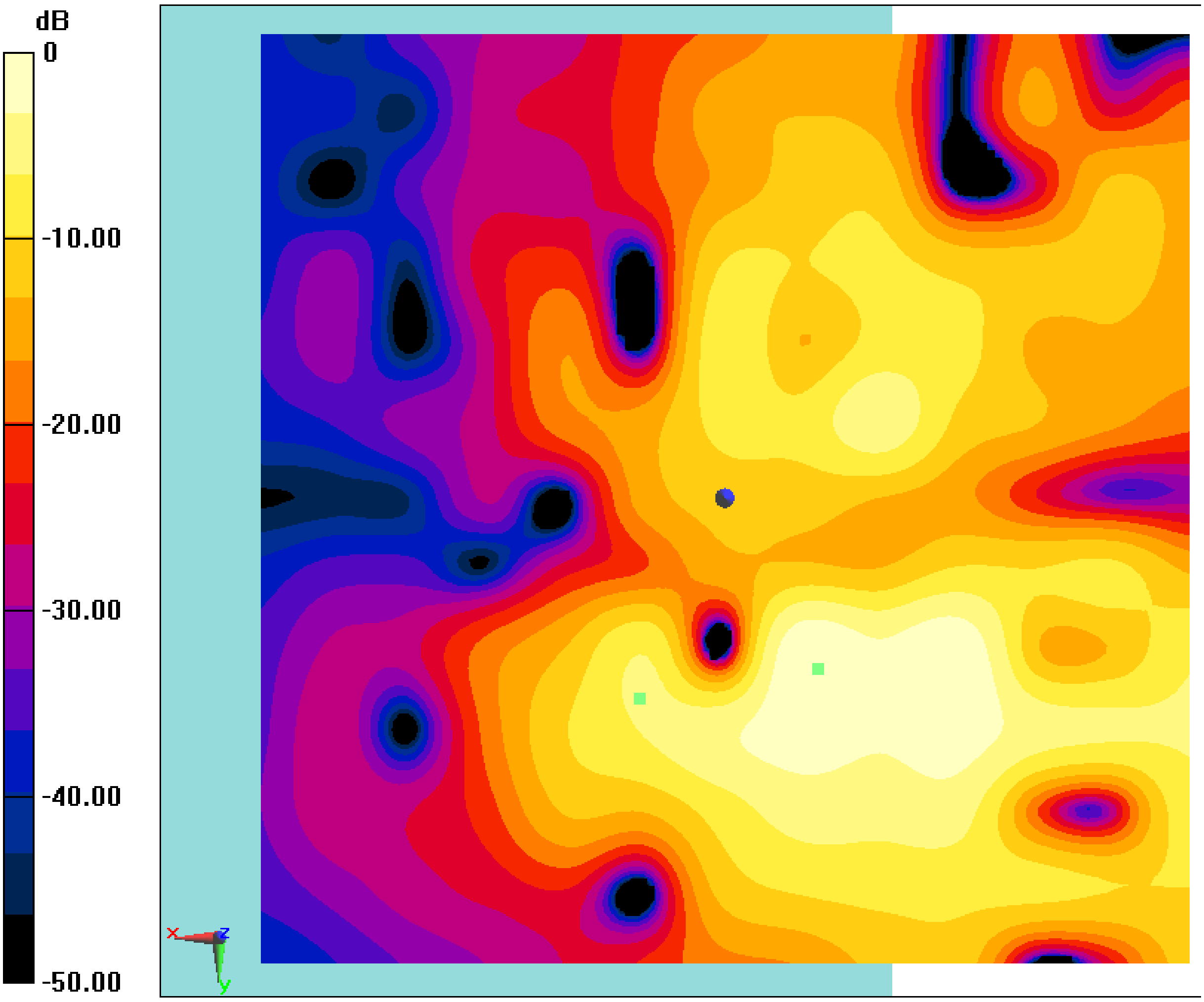
T-Coil WiFi-2.4G 11b Transverse
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5ºC
Communication System: WiFi-2.4G; Frequency: 2437 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

y (transversal) 4.2mm 50 x 50/ABM Interpolated Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 = 1.19 dBA/m
BWC Factor = 0.16 dB
Location: 4.6, 10.8, 3.7 mm

y (transversal) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 39.69 dB
ABM1 comp = -1.07 dBA/m
BWC Factor = 0.16 dB
Location: -5, 9.2, 3.7 mm



0 dB = 1.147 A/m = 1.19 dBA/m

Fig F.4.5 T-Coil WiFi-2.4G

T-Coil WiFi-2.4G 11b Perpendicular
Date: 2020-1-15
Electronics: DAE4 Sn1331
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature:22.5ºC
Communication System: WiFi-2.4G; Frequency: 2437 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

z (axial) 4.2mm 50 x 50/ABM Interpolated Signal(x,y,z) (121x121x1):

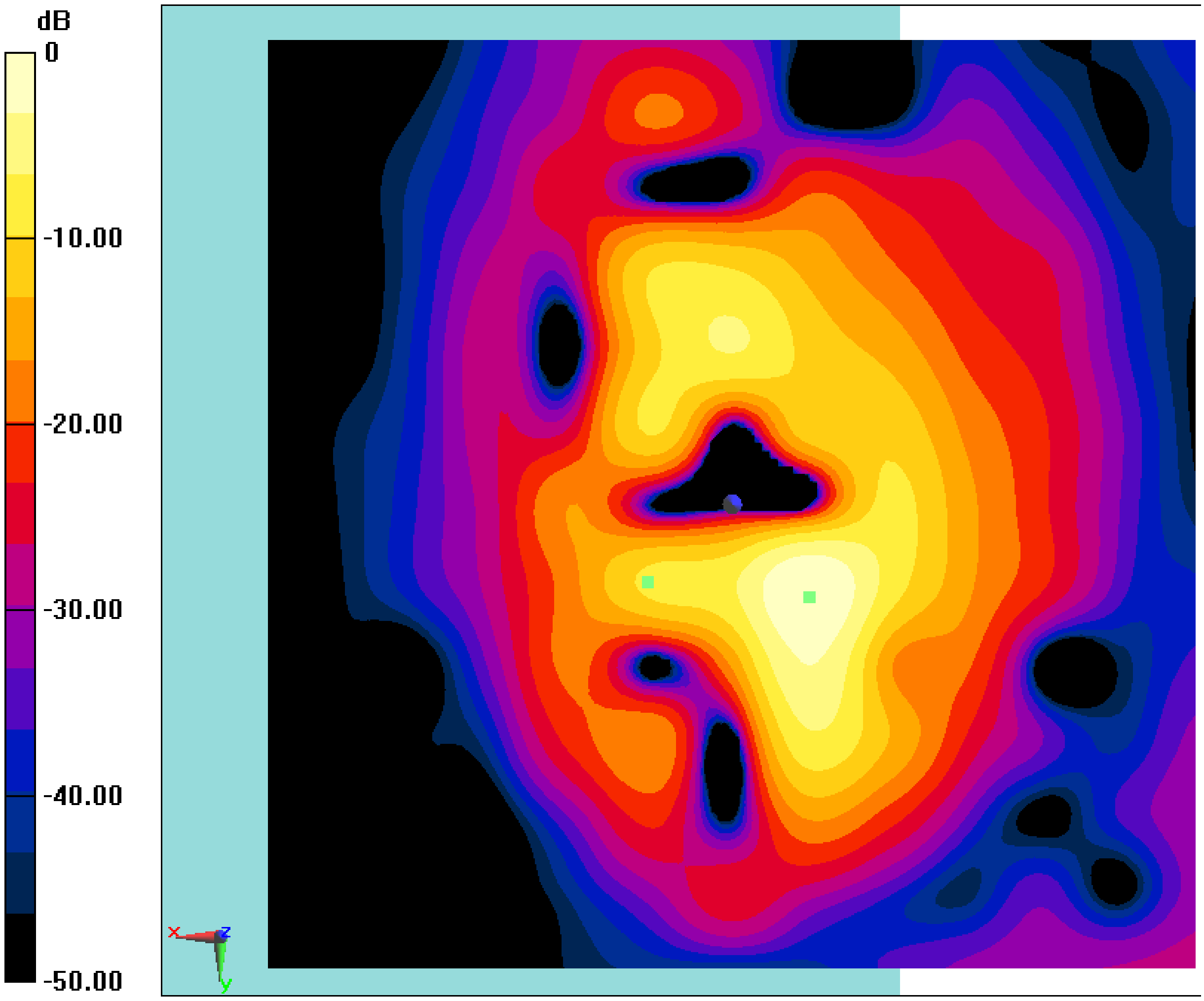
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1 = 9.08 dBA/m
BWC Factor = 0.16 dB
Location: 4.6, 4.2, 3.7 mm

z (axial) 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 100
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

Cursor:
ABM1/ABM2 = 45.91 dB
ABM1 comp = 6.05 dBA/m
BWC Factor = 0.16 dB
Location: -4.2, 5, 3.7 mm



0 dB = 2.846 A/m = 9.08 dBA/m

Fig F.4.6 T-Coil WiFi-2.4G

F.5 Frequency respond curves of spot check

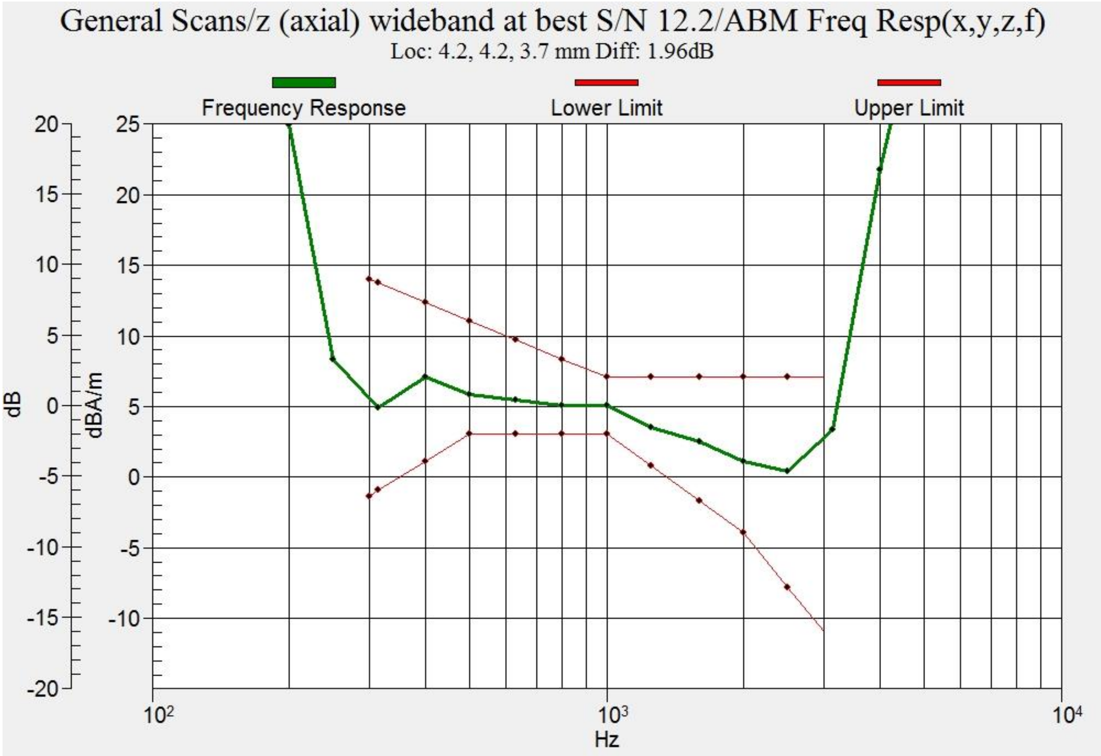


Figure F.5.1 Frequency Response of GSM 850

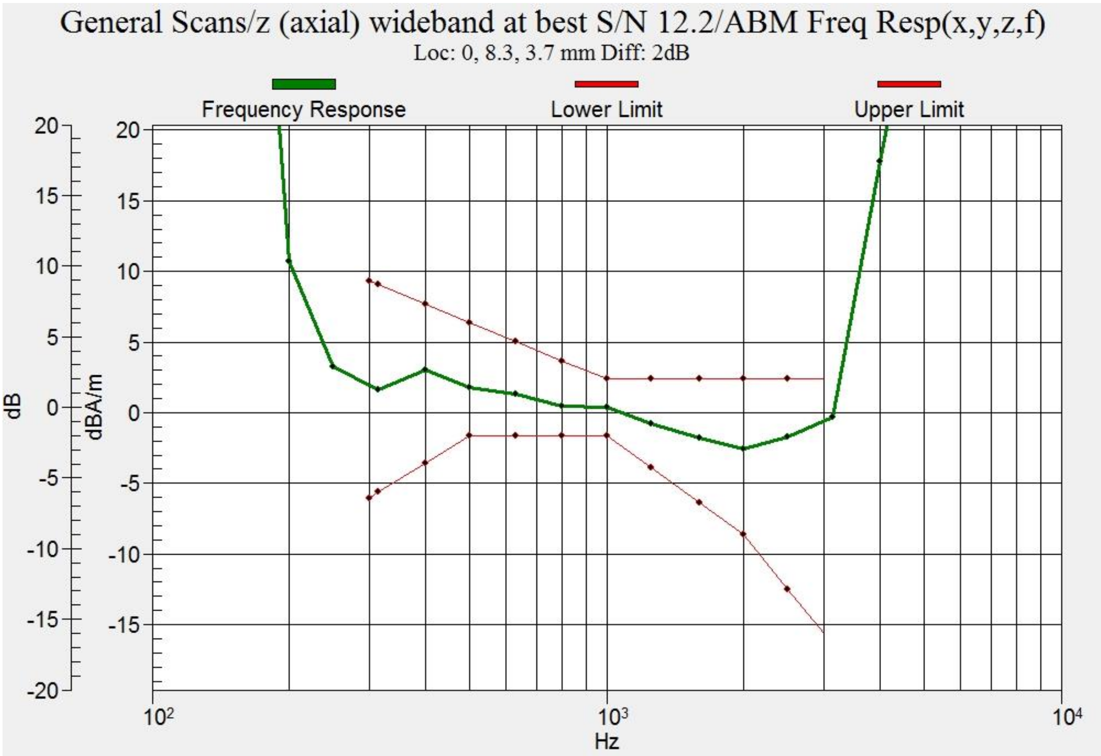


Figure F.5.2 Frequency Response of WCDMA 1900

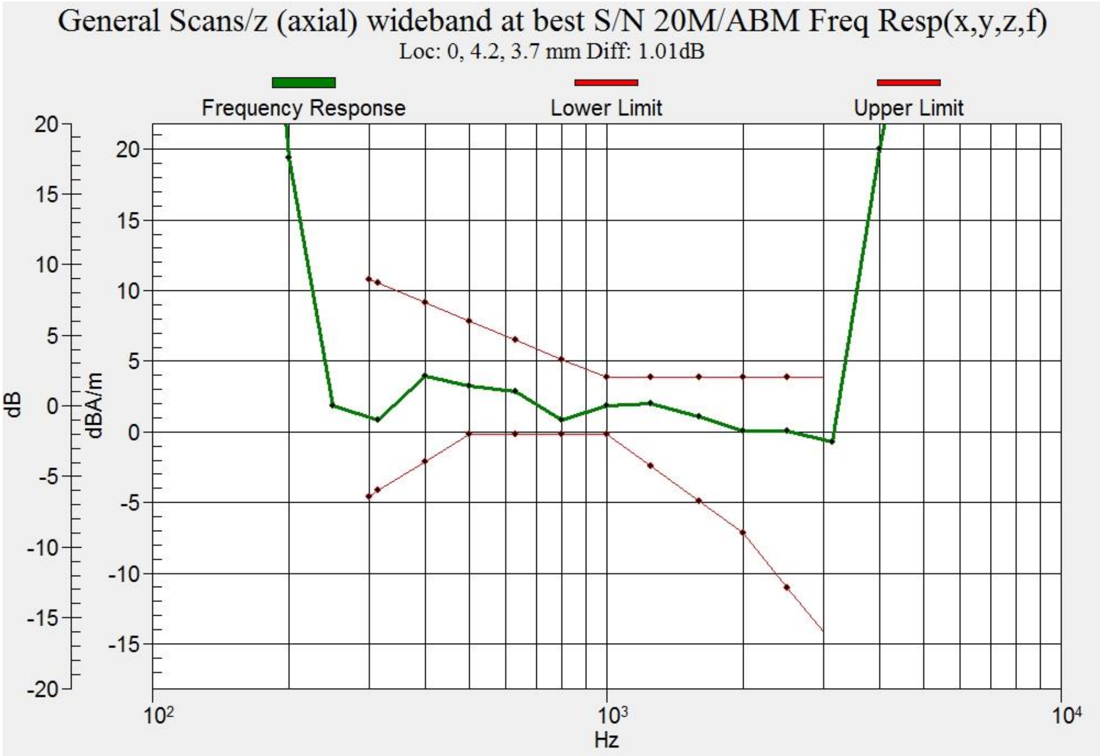


Figure F.5.3 Frequency Response of LTE B2

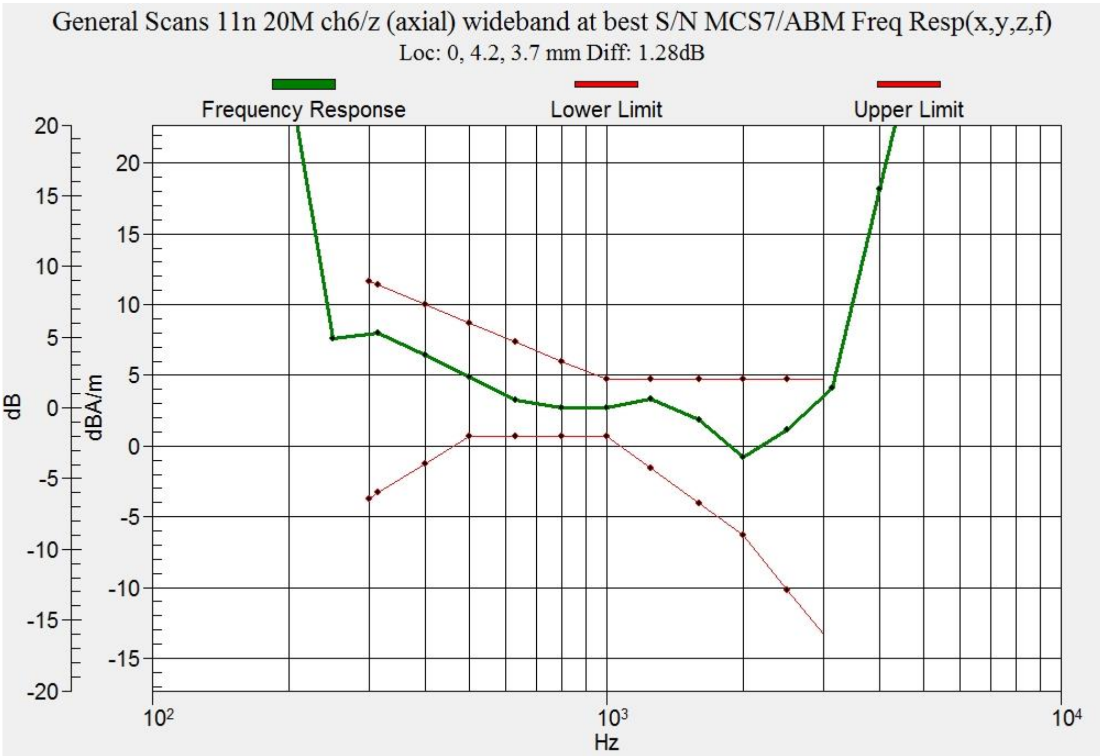


Figure F.5.4 Frequency Response of WiFi 2.4G

F.6 Frequency respond curves of Google duo

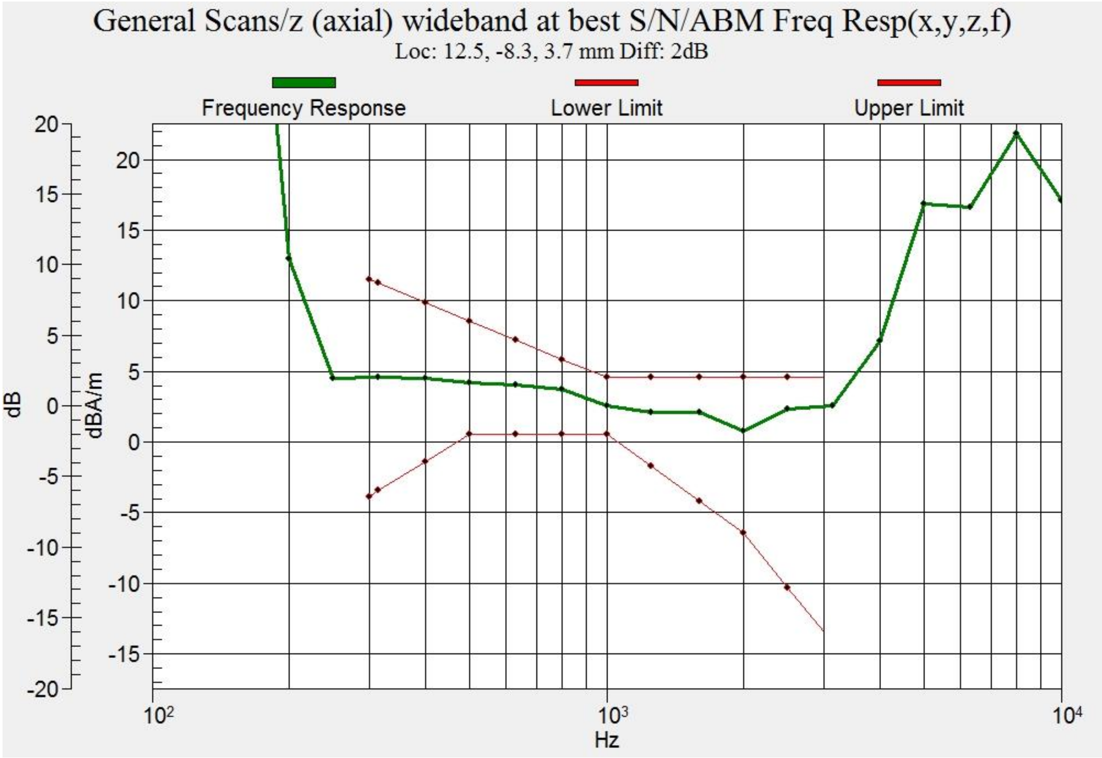


Figure F.6.1 Frequency Response of WCDMA 1700

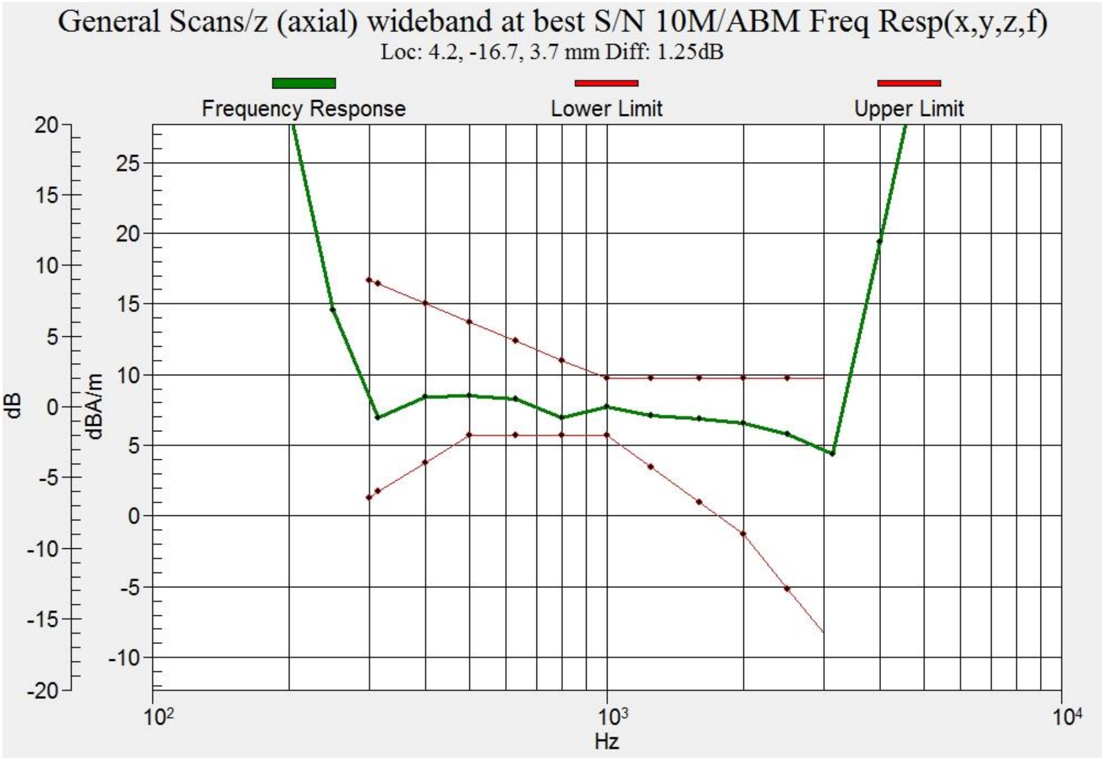


Figure F.6.2 Frequency Response of LTE B4

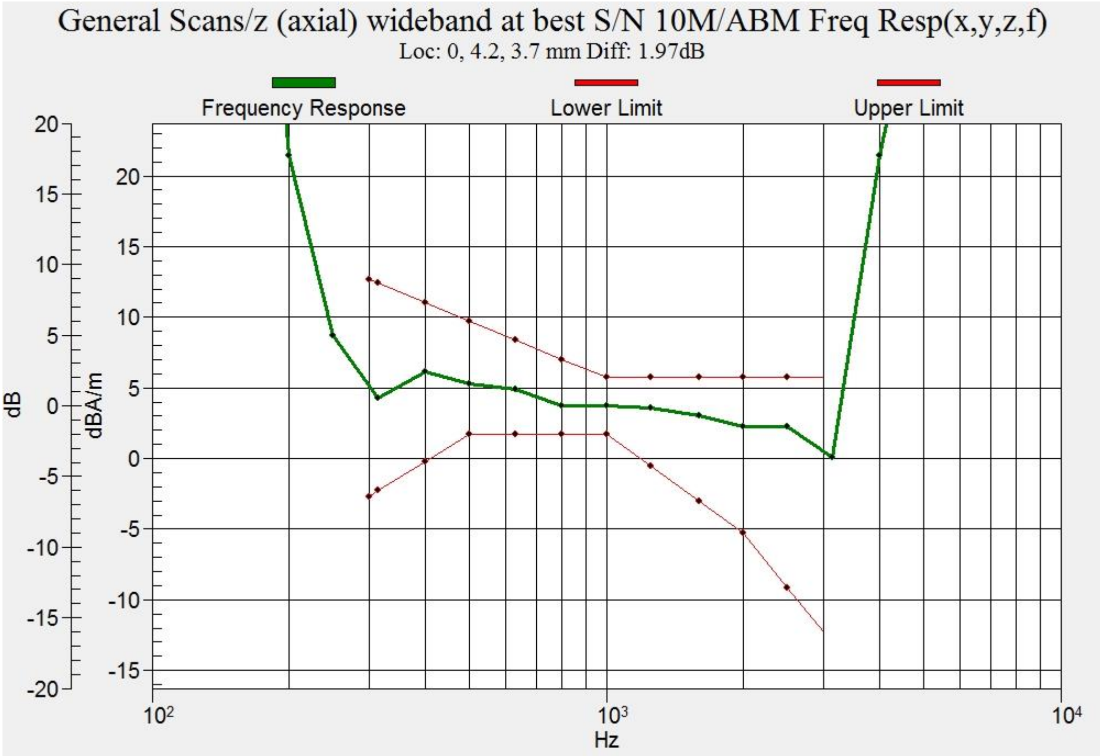


Figure F.6.3 Frequency Response of WiFi 2.4G

The photos of HAC test are presented in the additional document:

Appendix to test report no. I19Z62348-SEM01/02

The photos of HAC test